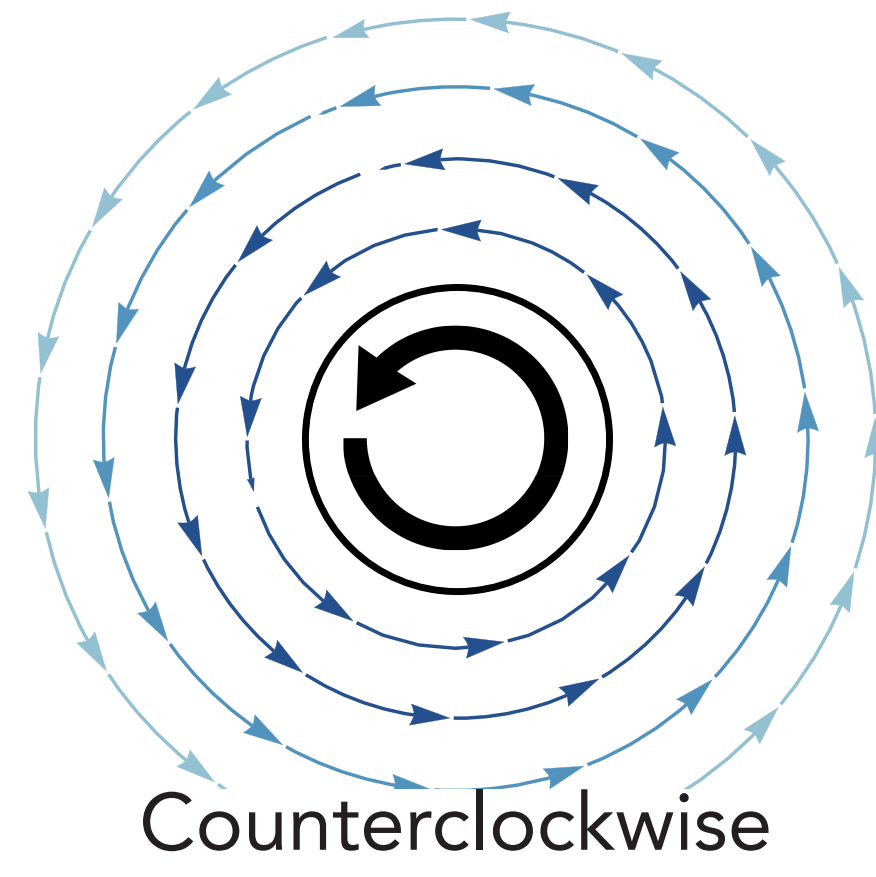
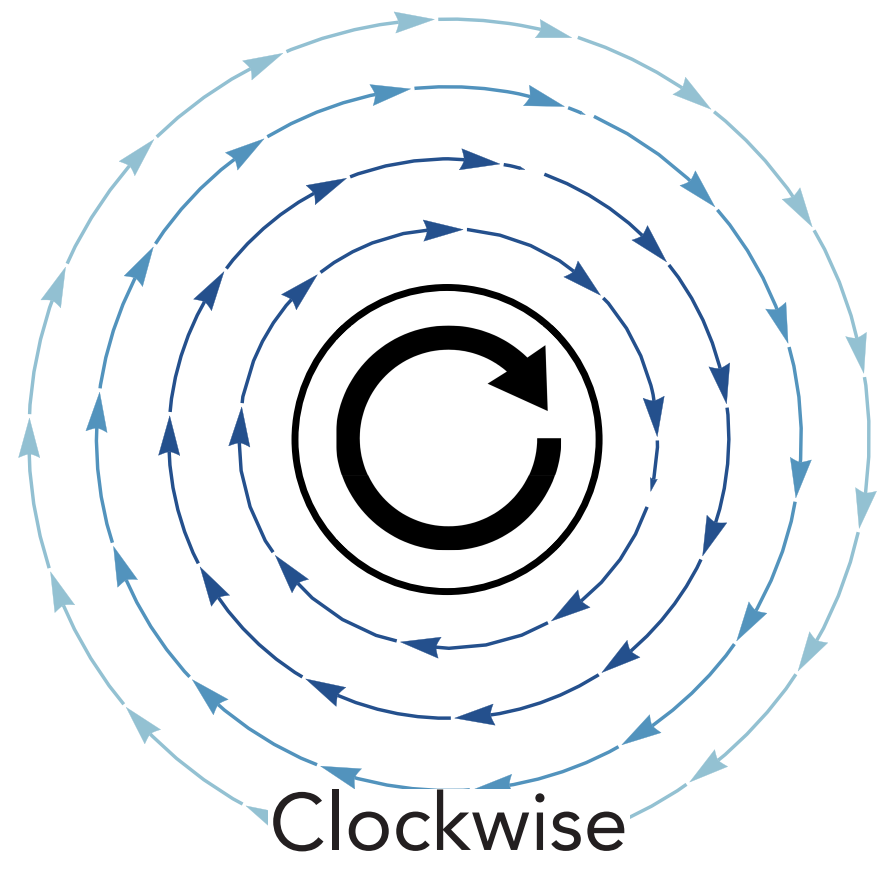


A model for tracking the wakes of vertical axis turbines

Leland Kirshen, Shreyas Mandre & Elliot Weiss

Abstraction: vertical axis turbine = bound vortex



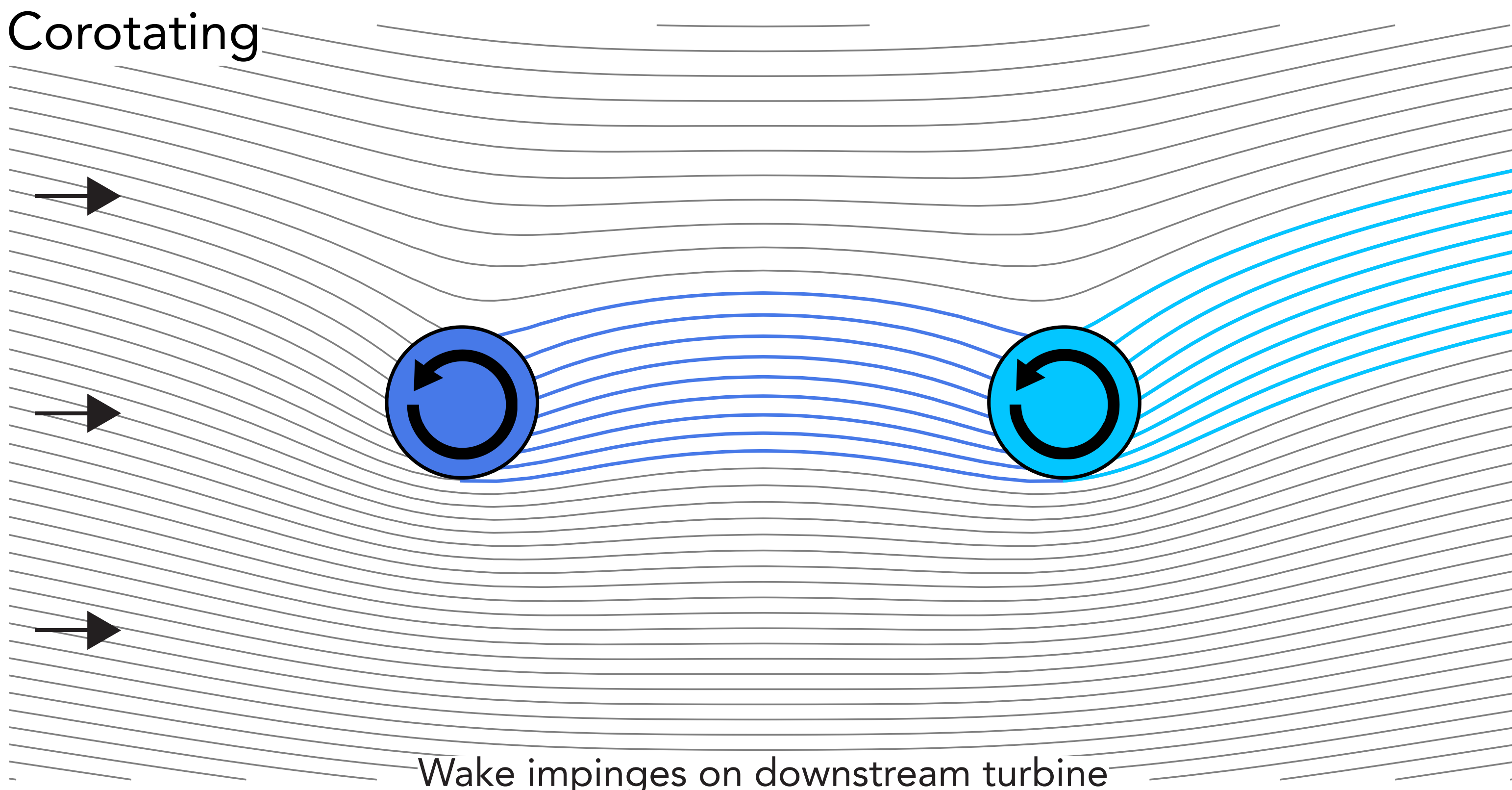
Objective:

Track streamlines through turbines

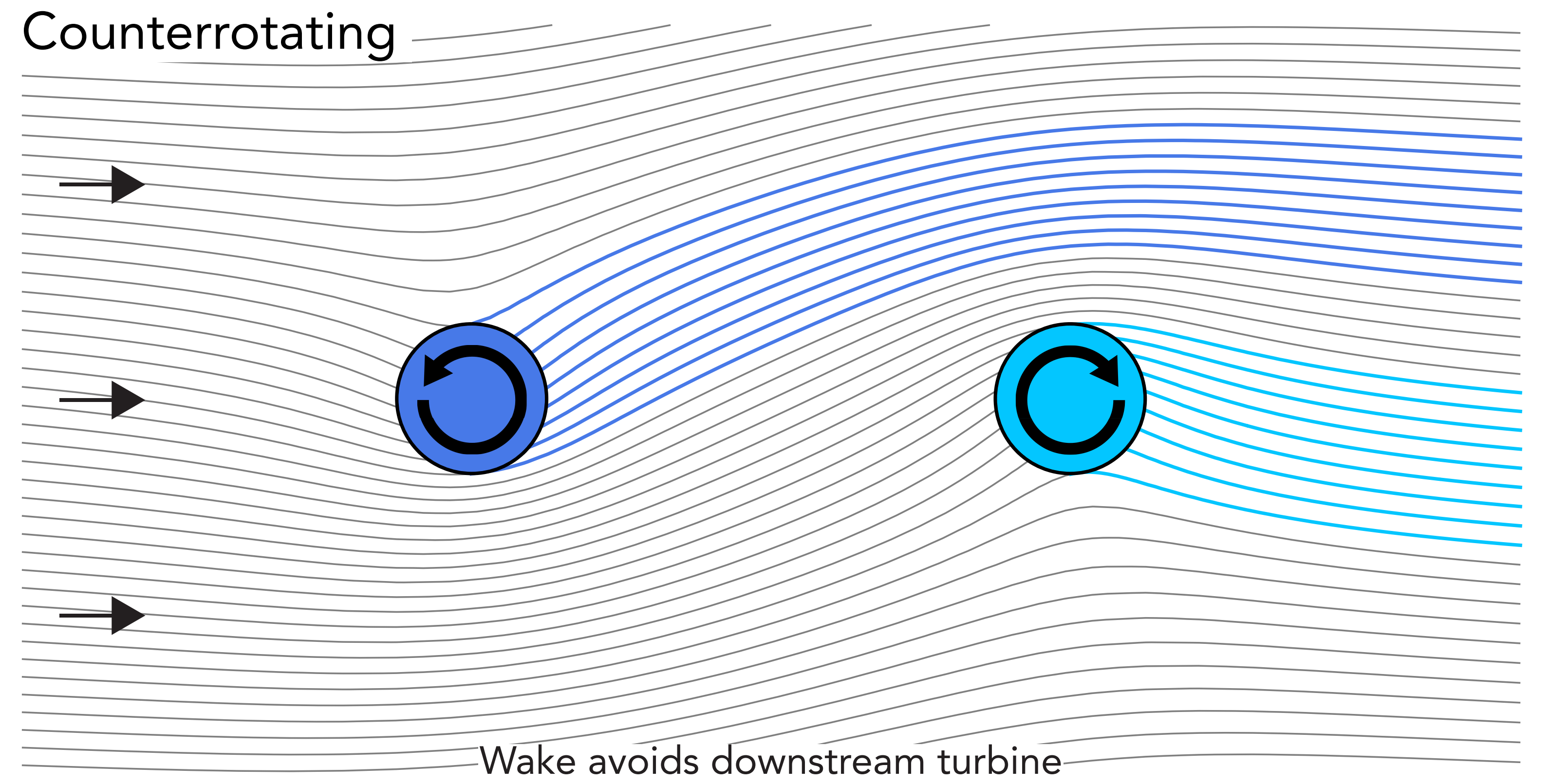
Ignore energy extraction, turbulence*

Arrangements of two turbines

Corotating

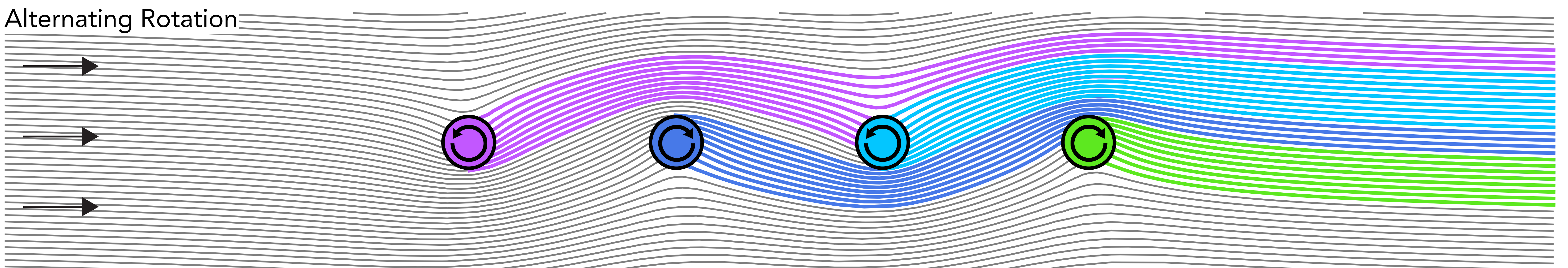


Counterrotating

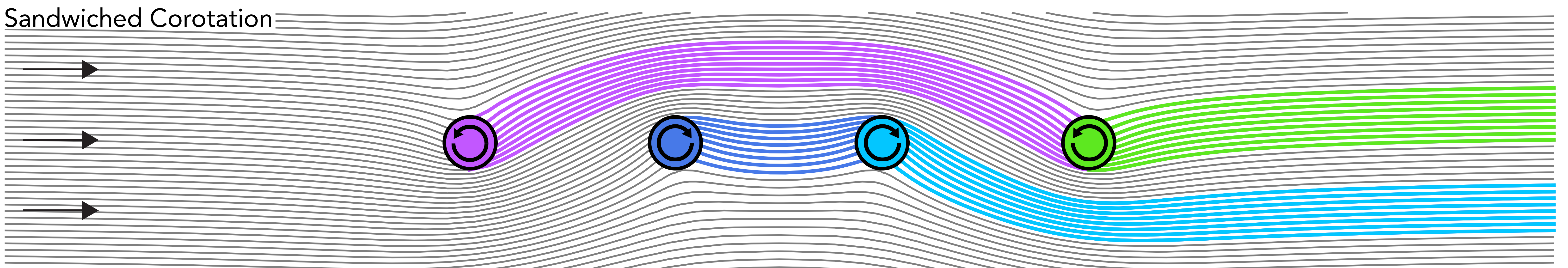


Promising arrangements of four turbines

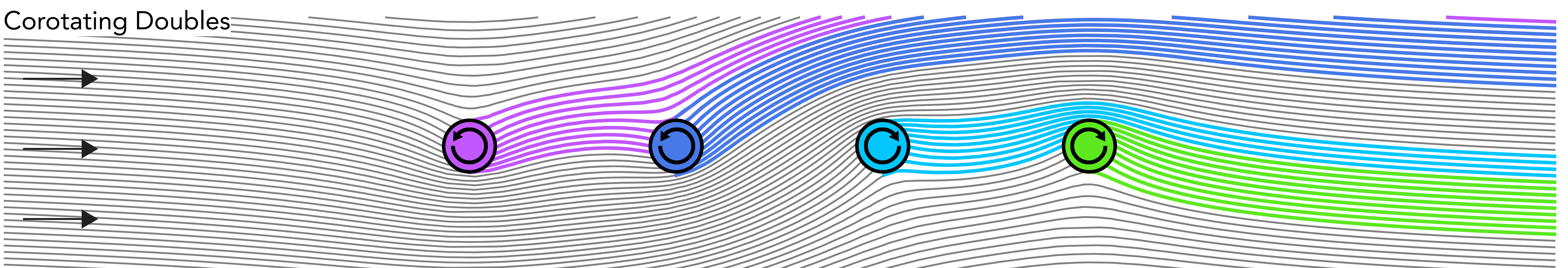
Alternating Rotation



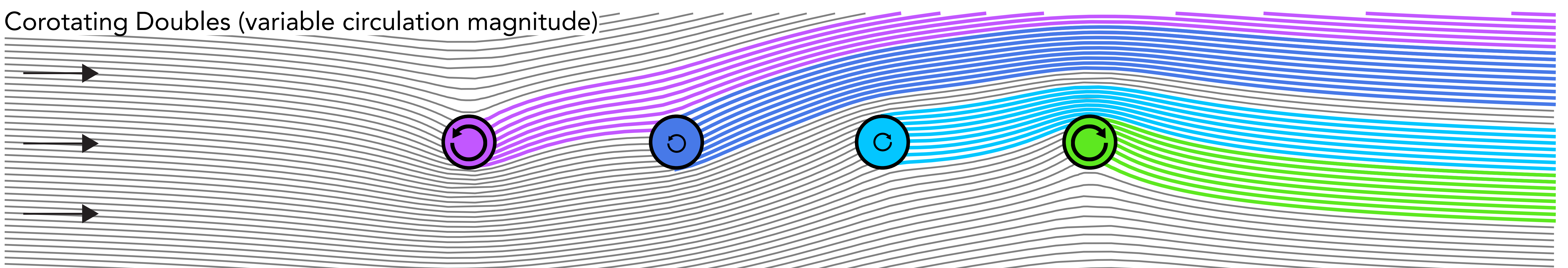
Sandwiched Corotation



Corotating Doubles



Corotating Doubles (variable circulation magnitude)



* We expect the effect of turbulent mixing between wake and freestream flow to replenish the kinetic energy deficit in the wake. The longer the fluid in the wake travels, the more closely its kinetic energy approaches the freestream value. Thus, downstream turbines experience higher energy flow from wakes that travel further. Therefore, we seek arrangements where the wake of each turbine travels a maximal distance before impinging on downstream turbines. A detailed computational or experimental analysis accounting for turbulence and energy extraction is too expensive to undertake for all possible turbine arrangements. These results systematically identify promising arrangements of four turbines and are easily extensible to larger arrays for such analysis.